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(Reaffirmed 1996)

Indian Standard

CODE OF PRACTICE FOR ANCILLARY STRUCTURES IN SEWERAGE SYSTEM

PART 1 MANHOLES

(First Revision)

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INDIAN STANDARDS INSTITUTION
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Indian Standard

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(*Continued on page* 2)

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Indian Standard

CODE OF PRACTICE FOR ANCILLARY STRUCTURES IN SEWERAGE SYSTEM

PART 1 MANHOLES

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 13 January 1986, after the draft finalized by the Water Supply and Sanitation Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Manholes form one of the essential ancillary structures in any sewerage system. They are generally provided at every change of alignment or gradient of sewers at every junction of two or more sewers, at head of all sewers or branches, wherever there is a change in size of sewer and at regular intervals in the sewerage system. They are used for inspection, cleaning and repairing of sewers and other maintenance operations. This standard was first published in 1967 with a view to giving guidance on proper design and construction of manholes. Salient changes made in this revision are:

a) Spacing and sizes of manholes have been modified and given in detail;

b) Arch type and circular manholes have been covered in detail;

c) Guidance for design of manholes has been elaborated;

d) Brickwork construction and plastering have been modified and given in detail;

e) Construction details of channels and benching inside the manhole have been covered in detail;

f) Guidance for fixing rungs and manhole covers and frames have been included; and

g) When two sewers meet at a different level, the guidance for providing drop manholes has been given in detail.

0.3 The other parts in series are:

a) IS : 4111 (Part 2)-1985 Code of practice for ancillary structures in sewerage system: Part 2 Flushing tanks (*first revision*).

b) IS : 4111 (Part 3)-1985 Code of practice for ancillary structures in sewerage system : Part 3 Inverted syphon (*first revision*).

c) IS : 4111 (Part 4)-1968 Code of practice for ancillary structures in sewerage system: Part 4 Pumping stations and pumping mains (rising mains).

0.4 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard covers types of manholes, design considerations for manholes and their construction and safety requirements.

1.2 This standard applies to manholes built for public sewers and does not cover manholes built specifically for building drainage (*see* IS : 1742-1983†).

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Access Shaft — The vertical passage to the manhole chamber from the manhole cover.

2.2 Benching — Sloping surfaces having slope in transverse direction constructed on either side of channels at the base of manholes or inspection chamber for the purpose of confining the flow of sewage, avoiding the accumulation of deposits and providing a safe working platform.

2.3 Channel — The open waterway through which sewage, storm water or other liquid wastes flow at the invert of a manhole.

2.4 Deep Manhole — A manhole of depth greater than 1·65 m.

2.5 Depth of Manhole — The vertical distance from the top of the manhole cover to the outgoing invert of the main drain channel.

*Rules for rounding off numerical values (*revised*).

†Code of practice for building drainage (*second revision*).

2.6 Invert — The lowest point of the interior of a sewer or drain at any cross-section. In a manhole chamber, the lowest point of channel in the floor of the chamber which carries the flow of sewage through the manhole.

2.7 Manhole — An opening by which a man may enter or leave a drain, a sewer or other closed structure for inspection, cleaning and other maintenance operations, fitted with a suitable cover.

2.8 Manhole Chamber — Any chamber constructed on a drain or sewer so as to provide access for inspection, testing or the clearance of obstruction.

2.9 Soffit — The highest point of the internal surface of a sewer or culvert at any cross-section.

3. DESIGN CONSIDERATIONS

3.1 Design considerations are broadly based on three items, namely, spacings of manholes, access shaft and their sizes.

3.2 Spacing of Manholes

3.2.1 *General* — Manholes should be built at every change of alignment, gradient or diameter, at the head of all sewers and branches, at every junction of two or more sewers. On sewers which are to be cleaned manually which cannot be entered for cleaning or inspection the maximum distance between manholes should be 30 m.

3.2.2 The spacing of manholes on large sewers above 900 mm diameter is governed by the following for the sewers to be cleaned manually:

a) The distance which silt or other obstruction may have to be conveyed along the sewer to the nearest manhole for removal;

b) The distance through, materials for repairs may be conveyed through the sewer; and

c) Ventilation requirements for men working in the sewer.

3.2.2.1 The spacing of manholes above 90 to 150 m may be allowed on straight runs for sewers of diameter above 900 to 1 500 mm and above 150 to 200 m the spacing of manholes may be on straight runs for sewers of 1·5 to 2·0 m dia, which may further be increased up to 300 m for sewers of over 2 m diameter. A spacing allowance of 100 m per 1 m dia of sewer is a general rule in case of very large sewers.

3.2.3 Sewers which are to be cleaned with mechanical devices, the spacing of manhole will depend upon the type of equipment to be used for cleaning sewers.

3.3 Sizes of Manholes

3.3.1 Manholes shall be of such size as will allow necessary cleaning and inspection of manholes. These may be rectangular, arch type or circular in plan.

3.3.2 *Rectangular Manholes* — The minimum internal sizes of rectangular manholes between brick faces shall be as follows:

a) For depths less than 0·90 m, 900 × 800 mm as shown in Fig. 1; and

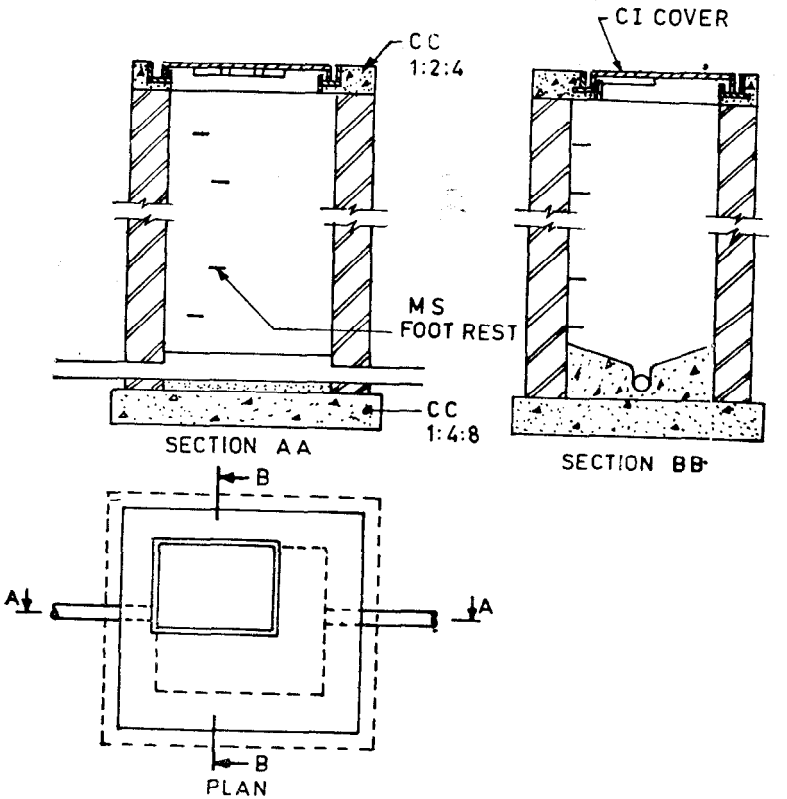


FIG. 1 TYPICAL ILLUSTRATION OF RECTANGULAR MANHOLE FOR DEPTHS LESS THAN 0·90 m (SIZE 900 × 800 mm)

b) For depths from 0·90 m and up to 2·5 m, 1 200 × 900 mm as shown in Fig. 2.

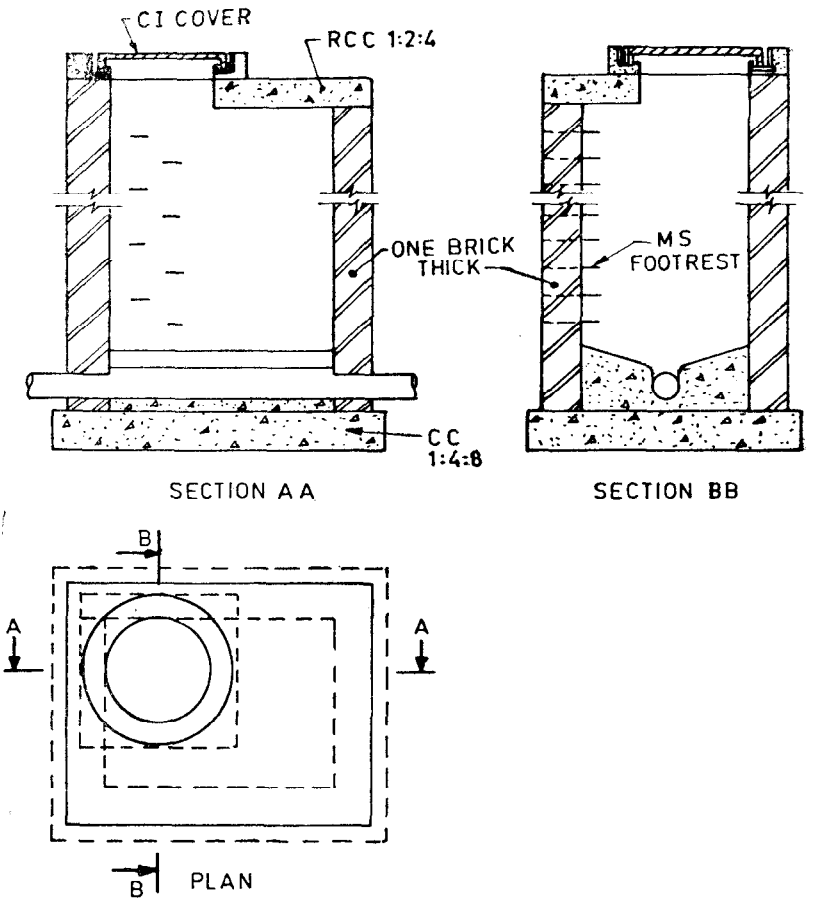


FIG. 2 TYPICAL ILLUSTRATION OF RECTANGULAR MANHOLE FOR DEPTHS FROM 0·90 m UP TO 2·5 m (SIZE 1 200 × 900 mm)

3.3.3 *Arch Type Manholes* — For depths of 2·5 m and above, arch type manholes will be provided and the internal sizes of chambers between brick faces shall be 1 400 × 900 mm as shown in Fig. 3.

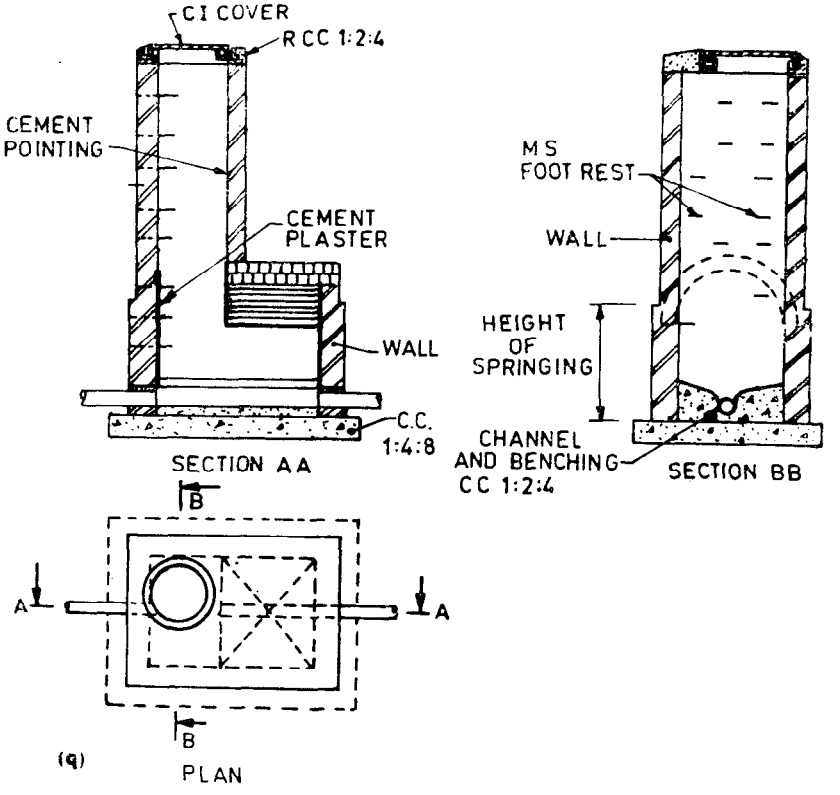


FIG. 3 TYPICAL ILLUSTRATION OF ARCHED TYPE MANHOLE

The width of manhole chamber shall be suitably increased more than 900 mm on bends, junctions or pipes with diameter greater than 450 mm so that the benching width on either side of channel is minimum 200 mm.

3.3.4 *Circular Manholes* — The circular manholes may be constructed as alternative to rectangular and arch type manholes.

Circular manholes are much stronger than rectangular and arch type manholes and thus these are preferred over rectangular (ordinary) as well as arch type of manholes.

The circular manholes can be provided for all depths starting from 0·9 m. Circular manholes are straight down in lower portion and slanting in top portion so as to narrow down the top opening equal to internal dia of manhole cover. Depending upon the depth of manhole, the diameter of manhole changes. The internal diameter of circular manholes may be kept as following for varying depths:

a) For depths above 0·90 m and up to 1·65 m — 900 mm diameter

b) For depths above 1·65 m and up to 2·30 m — 1 200 mm diameter

c) For depths above 2 30 m and up to 9·0 m — 1 500 mm diameter

d) For depths above 9·0 m and up to 14·0 m — 1 800 mm diameter

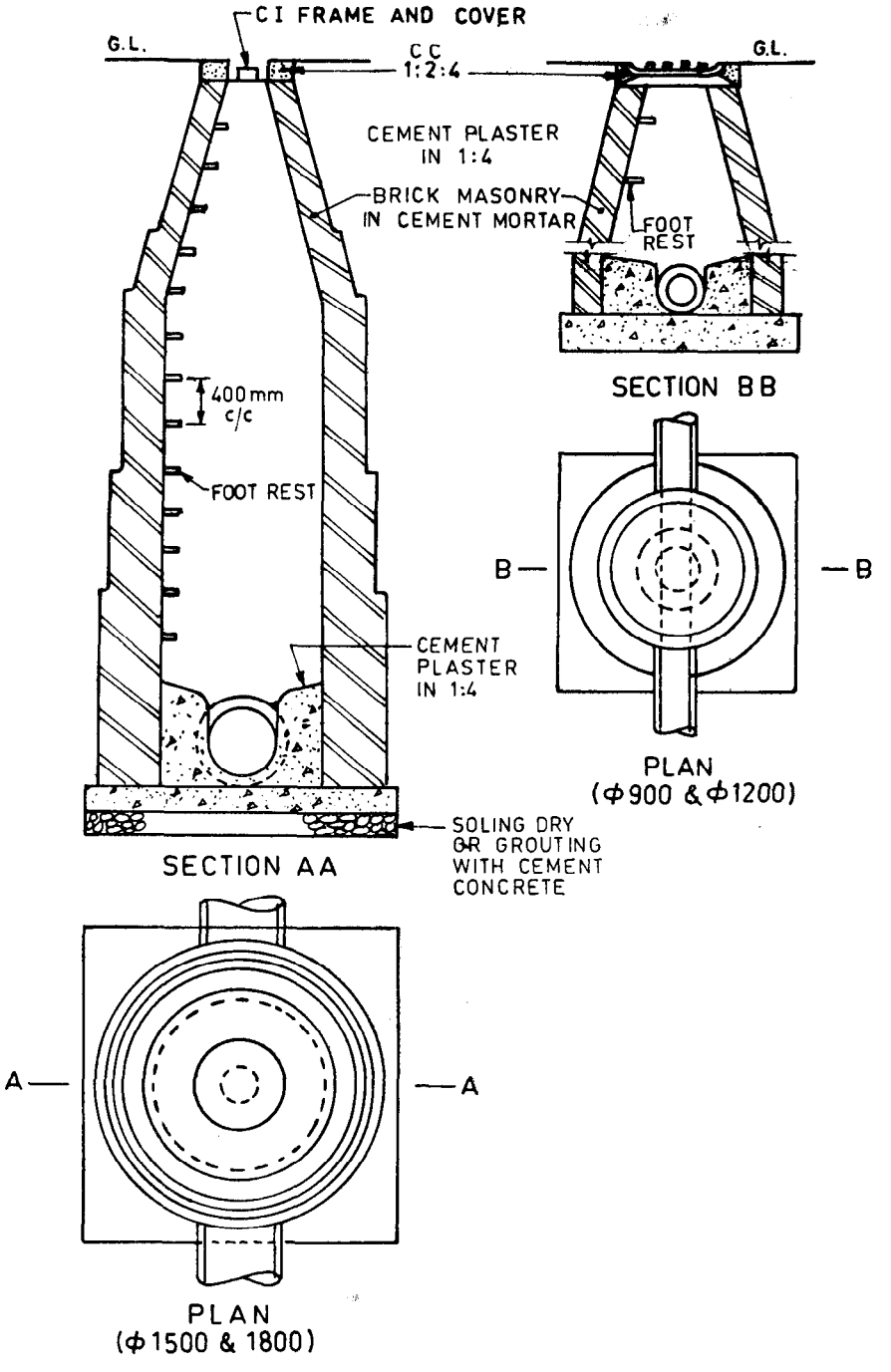
Some typical designs of circular manholes have been shown in Fig. 4.

3.3.5 If the sewer is constructed in a tunnel, the manhole should be located at the access or working shafts and the manhole chamber may be constructed of a size to suit the working shaft or *vice-versa*.

3.4 Access Shafts for Large Sewers — Access shaft shall be circular in shape and shall have a minimum internal dia of 750 mm; where the depth of the shaft exceeds 3 m suitable dimensions shall be provided to facilitate cleaning and maintenance.

3.4.1 Access shaft where built of brickwork should be corbelled on three sides to reduce it to the size of the opening in the cover frame, and to provide easy access on the fourth side to step irons or ladder. In determining sizes, regard should be paid to the dimensions of the maintenance equipment likely to be used in the sewers.

3.5 Where the diameter of the sewer is increased, the crown of the entering and leaving pipes shall be fixed at the same level and necessary slope is given in the invert of the manhole chamber. In exceptional cases and where unavoidable, the crown of entering sewer may be fixed at lower level but in such cases too the peak flow level of the two sewer shall be kept the same.



All dimensions in millimetres.

FIG. 4 TYPICAL ILLUSTRATION OF CIRCULAR MANHOLES

3.6 When smaller sewer joins the main sewer, the invert of smaller sewer at its junction with main shall be at least $\frac{2}{3}$ the diameter of the main above the invert of the main.

3.7 The branch sewer shall deliver sewage in the manhole in the direction of main flow and the junction should be made with care so that flow in main is not impeded.

3.8 No drain from house fittings, for example, gully trap or soil pipe, etc, to manhole shall normally exceed a length of 6 m unless it is unavoidable.

3.9 When manholes are constructed on footpath, these shall be provided with covers of medium duty casting and when built with the width of road under vehicular traffic, these shall be provided with cover of heavy duty casting.

4. CONSTRUCTION

4.1 Excavation — The manhole shall be excavated true to dimensions and levels as shown on the plan. The excavation of deep manholes shall be accompanied with safety measures like timbering, staging, etc (*see* IS : 3764-1966*). In areas where necessary, appropriate measures for dewatering should be made.

4.2 Bed Concrete — The manhole shall generally be built on a bed of concrete 1 : 4 : 8 (1 cement: 4 coarse sand: 8 graded stone aggregate 40 mm nominal size) unless it is otherwise required by the local bodies, etc. Generally the thickness of bed concrete shall be 225 mm for manholes of depth less than 2·30 m and 300 mm for depths of 2·30 m and above, unless otherwise specified on account of specific considerations. This may, however, be designed to carry safely the weight of walls, cover, the wheel loads, impact of traffic which are transmitted through cover and shaft walls and also for water pressure, if any. In case of weak soil, special foundation as suitable shall be provided.

4.3 The construction of manholes may either be done in brickwork or reinforced cement concrete work.

4.4 Brickwork — The thickness of walls shall be designed depending upon its shape and size and taking into account all loads coming over it including earth pressure and water pressure. Generally the brickwork shall be with first class bricks in cement mortar 1:5 (1 cement: 5 coarse sand). All brickwork in manhole chambers and shafts shall be carefully built in English Bond, the jointing faces of each brick being well buttered

*Safety code for excavation work.

with cement mortar before laying, so as to ensure a full joint. The construction of walls in brickwork shall be done in accordance with IS : 2212-1962*. For arched type of manholes, the brick masonry in arches and arching over pipes shall be in cement mortar 1:3 (1 cement: 3 coarse sand).

The thickness of wall shall in no case be less than one brick length. Generally the wall shall be built of one brick length thickness for depth less than 2·25 m. The thickness of wall for depths from 2·25 to 3·0 m is kept one and half brick length; for depth from 3·0 to 5·0 m, two brick length; for depths 5·0 to 9·0 m, two and half brick length and beyond 9·0 m depth it may be 3 brick length.

Where subsoil water condition exists, a richer mix may be used for masonry.

4.5 Plastering — The walls of manholes shall be plastered both inside and outside with cement mortar 1:3 (1 cement: 3 coarse sand) and finished smooth with a coat of neat cement.

Where subsoil water condition exists, a richer mix may be used and it shall further be waterproofed with addition of approved waterproofing compound in a quantity as per manufacturers specifications.

NOTE — Proper construction should be ensured to prevent moisture penetration. All manholes shall be constructed so as to be water tight under test.

4.6 A cement concrete collar of 75 mm minimum thickness using 13 mm aggregates and cement concrete of proportion 1:1½:3 (or Grade M 20) should be provided over the sewer where it passes through manhole walls, and a brick relieving arch (*see* IS : 2212-1962*) should be turned over the sewer pipe.

4.7 Channels and Benching — These shall be semi-circular in bottom half and of diameter equal to sewer. Above the horizontal diameter, sides shall be extended vertically 50 mm above the crown of sewer pipe and the top edge shall be suitably rounded off. The branch channels shall also be similarly constructed with respect to the benching but at their junction with main channel, an appropriate fall, if required suitably rounded off in direction of flow in the main channel, shall be given.

The channels and benching shall be done in cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and rendered smooth with neat cement. The rendered surface shall have a hard impervious finish obtained by using a steel trowel. The depth of channels and benching shall be as given in Table 1.

*Code of practice for brickwork.

TABLE 1 DEPTH OF CHANNELS AND BENCHING

Size of Drain	Top of Channel at the Centre Above Bed Concrete	Depth Benching at SideWalls Above Bed Concrete
(1)	(2)	(3)
100	150	200
150	200	300
200	250	350
250	300	400
300	350	450
350	400	500
400	450	550
450	500	600

4.8 Rungs — Rungs shall be provided in all manholes over 0·8 m in depth and shall preferably be of cast iron and of suitable dimensions (*see* IS : 5455-1969*). These rungs may be set staggered in two vertical runs, which may be 300 mm apart horizontally as well as vertically and shall project a minimum of 100 mm beyond the finished surface of the manhole wall. The top rung shall be 450 mm below the manhole cover and the lowest not more than 300 mm above the benching. Footrests shall be painted with coal tar, the portion embedded in masonry on cement concrete block being painted with thick cement slurry before fixing.

4.9 Manhole Covers and Frames — The size of manhole covers shall be such that there shall be clear opening of not less than 560 mm diameter for manholes exceeding 0·9 m depth. When cast iron manhole covers and frames are used they shall conform to IS : 1726 (Parts 1 to 7)-1974†. The frames of manhole shall be firmly embedded to concrete alignment and level in plain concrete on the top of masonry. After completion of the work, manhole covers shall be sealed by means of thick grease.

4.10 Reinforced Cement Concrete Manholes — Where sewers are to be laid in high sub-soil water conditions, manholes may be constructed in reinforced cement concrete of Grade M 20 or 1 : 1 $\frac{1}{2}$: 3 mix (*see* IS:456-1978‡). The manholes in this type of construction shall be preferably

*Specification for cast iron steps for manholes.

†Specification for cast iron manhole covers and frames:
Part 1 General requirements (*second revision*).
Part 2 Specific requirements of HD circular type (*second revision*).
Part 3 Specific requirements for HD double triangular type (*second revision*).
Part 4 Specific requirements for MD circular type (*second revision*).
Part 5 Specific requirements for MD rectangular type (*second revision*).
Part 6 Specific requirements for LD rectangular type.
Part 7 Specific requirements for LD square type.

‡Code of practice for plain and reinforced concrete (*third revision*).

circular type. The base and wall shall be designed for the factors as mentioned in **4.4**.

4.10.1 Walls may be constructed of brick masonry above the sub-soil water level. A typical illustration of a reinforced cement concrete manhole with brick masonry above the sub-soil water level is shown in Fig. 5.

5. WORKMANSHIP

5.1 Where practicable, the channel shall be made of the same material as the sewer. Where this is not practicable, concrete (of proportion 1:2:4) rendered smooth or plastered shall be used. Where there is no change of diameter, the invert shall be laid at the same gradient as the sewer.

5.2 The benching should have a fall towards the invert of about 1 in 12 for pipes up to 450 mm in diameter and should rise vertically from the springing to at least the height of the soffit of the sewer.

5.3 If a manhole is in agricultural land not likely to be developed the chamber walls (in shallow manholes) or shaft walls (in deep manholes) should, if possible, be built up to about 600 mm above natural ground surface and mound is made on all sides with earth.

5.4 In the case of a deep manhole the access shaft should be brought up to a suitable level to allow manhole cover and frame to be bedded on the top, the cover being at road level. The manhole frame should not be embedded in the RCC slab to facilitate replacement and adjustment where necessary. The reduction from the dimensions of the chamber to those of the shaft may be done in various ways:

a) By means of a concrete slab suitably reinforced to carry the weight of the ground above and all probable superimposed loads. The slab should not be less that 150 mm thick. Precast slabs of various types may also be used;

b) A brick arch turned over the chamber in one direction, and the brickwork corbelled inwards or a concrete lintel in the other;

c) In large manholes, brick arches at different levels and in both directions to effect the reduction in size; and

d) A shallow manhole should be covered by a slab similar to that described in (a) above. Where necessary, the cover frame should be bedded on brickwork, corbelled over to suit the size of cover frame to be used. (The adjustment to correct road level may be made in the brickwork.)

5.5 All corners shall be rounded off to a 75 mm radius with cement plaster (using one part of cement and three parts of sand, and finished smooth with a coat of neat cement), 13 mm thick and all rendered internal surfaces shall have a hard impervious finish obtained by using steel trowel.

6. SAFETY MEASURES

6.1 In deep manholes enlarged rest chambers should be made at about 6 m intervals, each provided with a landing platform in the form of a grating incorporating a hinged trap-door immediately under the ladder.

6.2 All manholes on sewers of 1 m diameter and over should be provided with provision for fixing safety chains (galvanized wrought-iron closelink, 6 or 10 mm) for placing across the mouth of the sewer on the down-stream side when men are at work, and galvanized pipe hand-rail (nominal 38 mm bore) should be provided on the edges of all benchings, platforms, etc, to prevent possibility of a man falling into the sewer.

6.3 If ground conditions are such as to give rise to excessive risk of settlement and consequential damage to the manhole or sewer a concrete slab shall be provided at the top of the shaft to receive the cover frame. This should be independent of the shaft in order to avoid transmitting traffic shocks to the manhole. Any subsidence of the backfilling on which the slab rests, shall be brought to the required road level without disturbing or damaging the pipe or the shaft.

6.4 No manhole shall be permitted inside a building or in any passage therein.

6.5 In cascades and ramps, hand-rails and chains should be provided for the safety of workmen.

7. TYPES OF MANHOLES

7.1 Straight-Through Manholes — The simplest type of manhole is that built on a straight run of sewer with no side junctions.

7.1.1 Where there is a change in the size of sewer, the soffit or crown level of the two sewers should be the same, except where special conditions require otherwise.

7.2 Junction Manholes — A manhole should be built at every junction of two or more sewers, and the curved portions of the inverts of tributary sewers should be formed within the manhole. To achieve this with the best economy of space, the chamber may be built of a shape other than rectangular. The soffit of the smaller sewer at a junction should be not lower than that of the larger, in order to avoid the surcharging of the former when the latter is running full, and the hydraulic design usually assumes such a condition.

7.2.1 The gradient of the smaller sewer may be steepened from the previous manhole sufficiently to reduce the difference of invert level at the point of junction to a convenient amount.

7.3 Side-Entrance Manholes — In large sewers, or where it is difficult to obtain direct vertical access to the sewer from ground level, owing to the existing services; gas, water, etc, the access shaft should be constructed in the nearest convenient position off the line of sewer, and connected to the manhole chamber by a lateral passage.

7.3.1 In tunnelled sewers the shaft and lateral access heading may be used as a working shaft, the tunnel being broken out from the end of the heading; or alternatively the shaft and heading may be constructed after the main tunnel is complete, provision having been made for breaking in from the access heading to build the chamber.

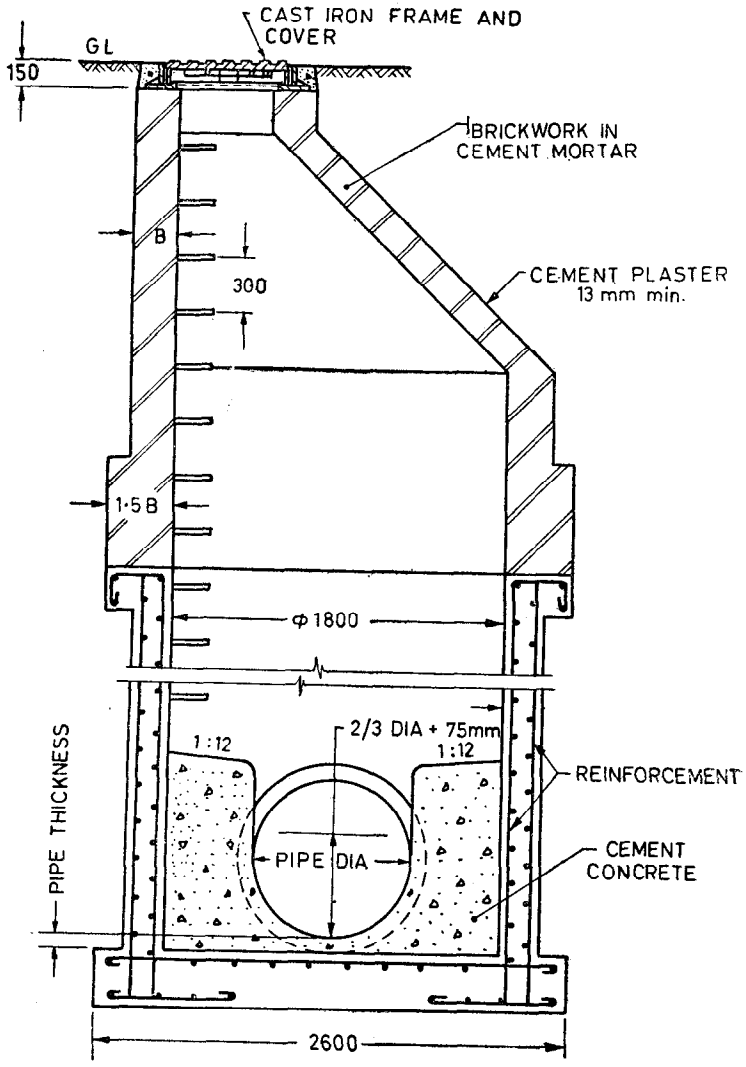
7.3.2 The floor of the side-entrance passage, which should fall at about 1 in 30 towards the sewer, should enter the chamber not lower than the soffit level of the sewer. In large sewer where the floor of the side-entrance passage is above the soffit either steps or a ladder (which should be protected either by a removable handrail or by safety chains) should be provided to reach the benching.

7.4 Drop Manholes — When a sewer connects with another sewer, where the difference in level between water lines (peak flow levels) of main line and the invert level of branch line is more that 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection within 600 mm, a drop connection shall be provided for which a manhole may be built incorporating a vertical or nearly vertical drop pipe from the higher sewer to the lower one. This pipe may be either outside the shaft and encased in concrete or supported on brackets inside the shaft, which should be suitably enlarged. If the drop pipe is outside the shaft, a continuation of the sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange. If the drop pipe is inside the shaft it should be in cast iron and it would be advantageous to provide adequate means for rodding and a water cushion of 150 mm depth should also be provided. The diameter of the back drop should be at least as large as that of the incoming pipe. A typical illustration of a drop manhole is shown in Fig. 6.

7.4.1 The drop pipe should terminate at its lower end with a plain or duck-foot band turned so as to discharge its flow at 45 degrees or less to the direction of the flow in the main sewer, and the pipe unless of cast iron should be surrounded with 150 mm of concrete.

7.4.2 In the case of sewers over 450 mm in diameter the drop in level may be accomplished by one of the following methods:

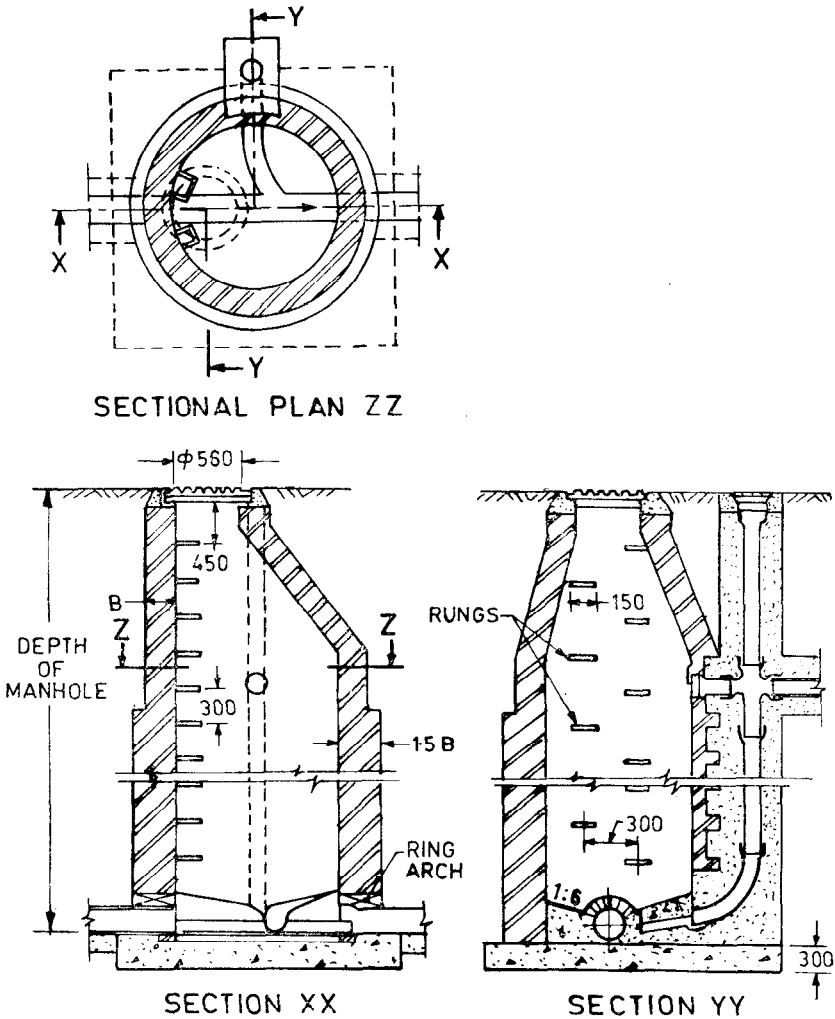
a) *A cascade* — This is a steep ramp composed of steps over which the flow is broken up and retarded. A pipe connecting the two levels is often concreted under the steps to allow small flows to pass without trickling over the steps. The cascade steps may be



B— Thickness of wall

All dimensions in millimetres.

FIG. 5 TYPICAL ILLUSTRATION OF RCC MANHOLE (CONCRETE NOT SHOWN)



All dimensions in millimetres.

FIG. 6 TYPICAL ILLUSTRATION OF DROP MANHOLE

made of heavy duty bricks of Class I quality (*see* IS : 2180-1985 *), cement concrete with granolithic finish, or dressed granite;

b) *A ramp* — A ramp may be formed by increasing the grade of the last length of the upper sewer to about 45 degrees or by constructing a steeply graded channel or culvert leading from the high level to the low level sewer. In order to break up the flow down the ramp and minimize the turbulence in the main sewer, the floor of a culvert ramp should be obstructed by raised transverse ribs of either brick or concrete at 1·15 m intervals, and a stilling pool provided at the bottom of the ramp; and

c) *By drops in previous successive manholes* — Instead of providing the total drop required at the junction manhole the same may be achieved by giving smaller drops in successive manholes preceding the junction manhole. Thus, for example, if a total drop of 2·4 m is required to be given, 0·6 m drops may be given in each of the previous three manholes and the last 0·6 m drop may be given at the junction manhole.

7.5 Scraper (Service) Type Manhole — All sewers above 450 mm in diameter should have one manhole at intervals of 110 to 120 m of scraper type. This manhole should have a clear opening of 1 200 × 900 mm at the top to facilitate lowering of buckets.

*Specification for heavy duty burnt clay building bricks (*second revision*).

(*Continued from page* 2)

Drainage Subcommittee, BDC 24 : 2

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